



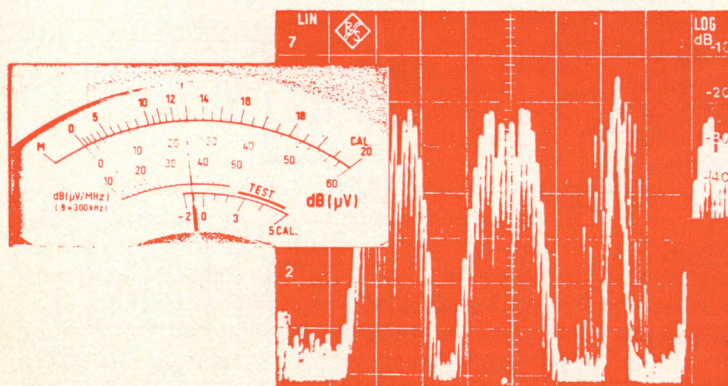
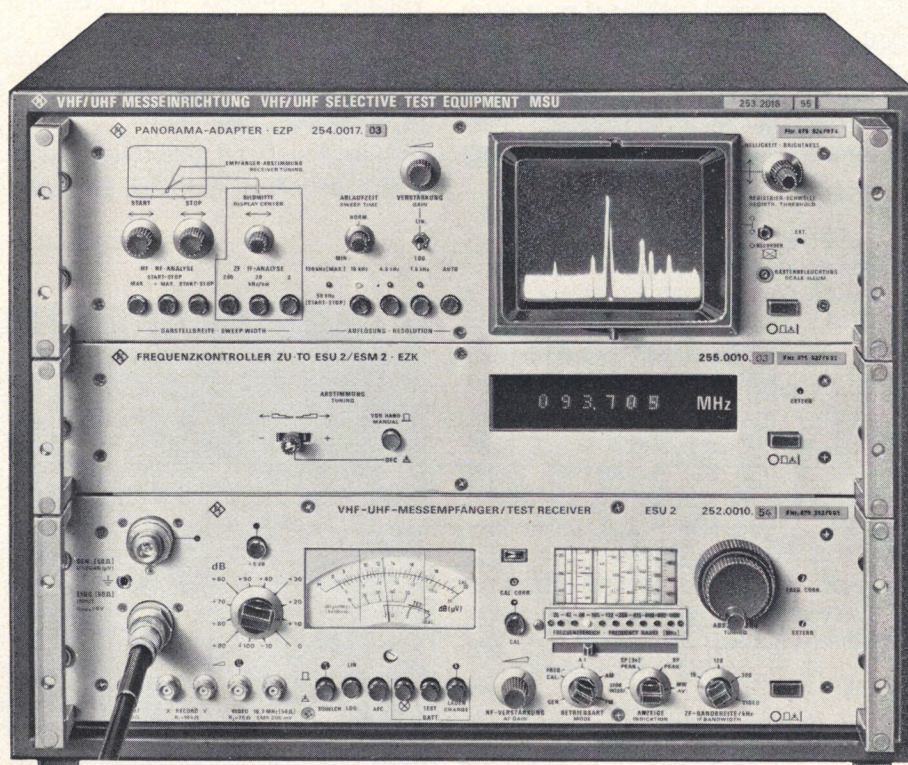
ROHDE & SCHWARZ
MÜNCHEN

MSU

VHF-UHF SELECTIVE TEST EQUIPMENT

25 to 1000 MHz
-10 to +120 dB(μ V)

Applications: Field-strength measurements using test antennas,
CISPR and MIL interference measurements, selective
voltage measurements, radiosurveillance and monitoring



RECEIVES
MEASURES
DISPLAYS

WITH HIGHEST PRECISION

093.705 MHz

Characteristics and Uses

The VHF-UHF Selective Test Equipment MSU is designed for the measurement, demodulation and frequency analysis of AM, FM and pulse-modulated signals, TV signals and interferences as well as for measurement on two-port networks, harmonic and intermodulation measurements. It is made up of the following units:

VHF-UHF Test Receiver ESU 2

Frequency Controller EZK

Panoramic Adapter EZP

In designing this system the aim was to achieve great ease of operation as well as precise and time-saving measurements. These requirements are met by the following characteristics: internal reference for **automatic voltage calibration**, i.e. quick and exact determination of the RF input level; manual tuning and **seven-digit receive-frequency indication** ensuring rapid and accurate tuning of the receiver; **high sensitivity** permitting exact evaluation, even of low input signals ($0.3 \mu\text{V}$); **wide** dynamic range and good image and IF suppression making for unambiguous measurements; **panoramic display** with sweep widths up to a frequency subrange of the ESU 2 permitting a quick survey of the selected reception range; **recording outputs** for recording or further processing of the received signals; TTL-compatibility of remote-control and slave-equipment connections.

The **frequency tuning** of the receiver is either made by hand on the set or externally by remote control.

With manual tuning the total frequency range from 25 to 1000 MHz is divided into nine subranges. Each subrange can be selected by means of a slide switch and the frequency on the drum scale adjusted continuously (resolution 100 kHz to 1 MHz) with the coarse/fine drive without reversal of the sense of rotation at the range end. The setting is digitally indicated with 1-kHz resolution on the Frequency Controller. Tuning indication, AFC and A1 demodulator also facilitate tuning of the receiver.

In the DFC (digital frequency control) mode of the EZK the selected frequency is held constant with crystal accuracy (resolution of display 100 Hz). This mode also offers the possibility of varying the receiver frequency at three different speeds with the aid of a Kellog switch. In addition, it can be digitally set via the remote-control input of the frequency controller (input data in BCD code).

Sensitivity. The typical values of the noise figure are 8 dB (up to 400 MHz) and 10 dB (400 to 1000 MHz). From this it follows that with the smallest bandwidth voltages of $0.3 \mu\text{V}$ can be measured.

Voltage calibration. The voltage-measurement circuits of the test receiver can be automatically calibrated at any frequency selected. The calibration is effected within one second and is initiated by pressing a pushbutton.

Display. Input and calibration signal are passed via a level switch. This switch extends the linear 20-dB

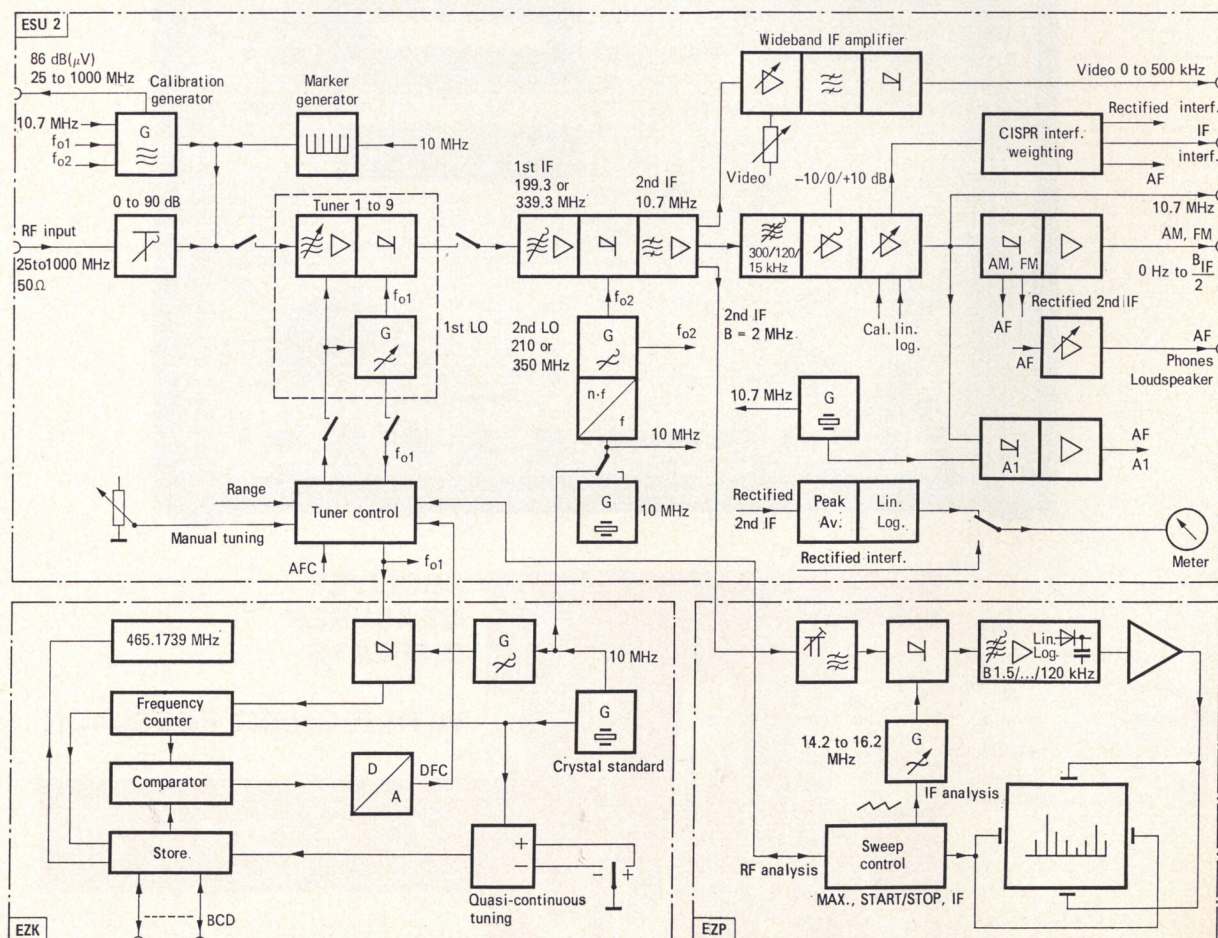


Fig. 1 Block diagram of MSU

indication range of the receiver in 10-dB steps to a total of -10 to $+120$ dB(μ V). The logarithmic display range of the test receiver (60 dB) and of the panoramic adapter (70 dB) are correspondingly increased. The following display modes can be selected: average, peak, VDE- and CISPR-weighted.

Bandwidths. Depending on the type and sensitivity of measurement or type of modulation one of the three bandwidths of the ESU 2 (15, 120 or 300 kHz) can be selected. The ESU 2 contains in addition a broadband amplifier which, via an AM demodulator, feeds the video output (0 to 500 kHz) for evaluation of pulse signals or signal-to-noise ratios by means of an oscilloscope.

Panoramic display. The EZP permits spectral display of the RF input signal within a frequency subrange of the ESU 2. It supplies a quick indication of the band occupancy, the level and frequency spacing of the signals as well as their modulation.

- a) **RF analysis** over one of the nine frequency subranges of the ESU 2 or an expanded extract thereof. By depressing the START/STOP button and positioning the START/STOP markers, any desired section of a subrange may be selected. The resolution is 120 kHz in accordance with CISPR for range display and 50 kHz for expanded-extract display. It is also possible to obtain range and extract display at the same time (on two lines). In all cases of broadband display the selected receiver frequency appears as a marker on the EZP screen to ease tuning to a particular signal.

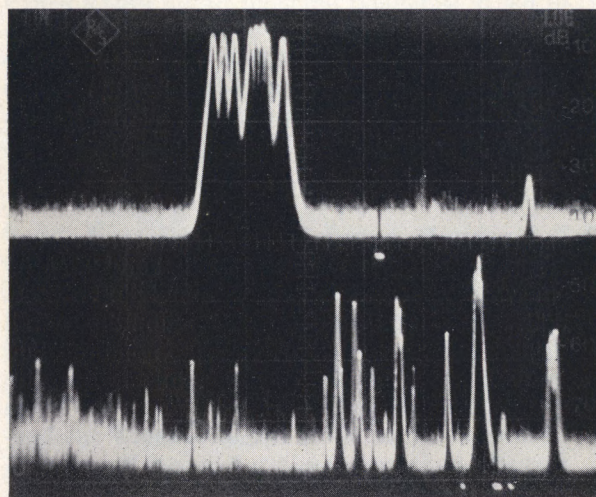


Fig. 2 RF analysis: Range display (105 to 172 MHz) with 120-kHz resolution (lower line); start/stop and receiver frequency markers define section displayed on upper line with 50-kHz resolution (public land-mobile radiotelephony channels).

- b) **IF analysis** with sweep widths of 2 MHz, 200 kHz and 20 kHz and switch-selected resolutions of 15 kHz, 4.5 kHz and 1.5 kHz. With the AUTO button depressed, the resolution necessary to ensure flickerfree display at the adjusted sweep width is set automatically. If another resolution bandwidth is selected, the minimum sweep time required is always set automatically. This can be continuously varied over a range of 5:1.

Outputs. In order to permit further processing or recording of the signals and test results, the Selective Test Equipment is provided with a number of outputs at which all important information can be derived. Two examples are:

Level recording and plotting of signal spectra with the aid of an YT or XY recorder.

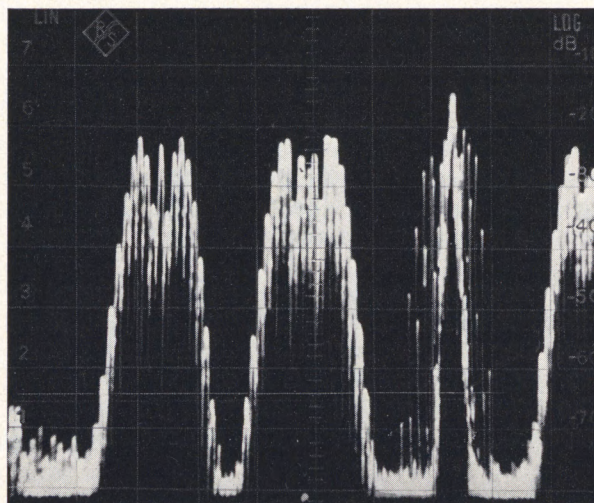


Fig. 3 IF analysis: Modulation spectrum of one occupied and three vacant public land-mobile radiotelephony channels; sweep width 200 kHz, resolution 1.5 kHz.

Measurements on four-terminal networks using the generator output and simultaneous display of the attenuation values on the EZP.

Programming. All settings can be externally controlled via remote control inputs. Depending on the application of the Selective Test Equipment, the control can either be effected by a Code Converter PCW (two when full remote control is required) and a Card Reader PCL or an IEC-bus-compatible calculator. The frequency is set digitally in BCD code. It is possible to use both manual and remote control simultaneously. For special applications users can easily create their own hardwired controllers. Slave units (ESU 2 and EZK) can easily be connected to the MSU.

Thanks to this configuration the Selective Test Equipment MSU can be used in a variety of applications:

As **field-strength meter** — in conjunction with the R&S Broadband Dipole HFU 2-Z1 (25 to 80 MHz) or the Log-periodic Broadband Antenna HL 023 (80 to 1300 MHz) — in the frequency range 25 to 1000 MHz with a measurement range the lower limit of which is between -7.5 and 13 dB(μ V/m) and the upper limit between 122.5 and 143 dB(μ V/m).

In conjunction with a clamp-on RF current probe (see recommended extras on last page) it is possible to measure **RF currents** from -30 to $+100$ dB(μ A) in the frequency range 25 to 300 MHz.

For **laboratories and test departments** the MSU will prove to be a most versatile selective voltmeter and

analyzer, offering many alternative ways of evaluating each input. The possibility of using both manual and programmed operation simultaneously will greatly speed up repetitive measurements.

The MSU is also suited for measurements on **TV systems**, including **CATV installations**. It permits, for instance, measurement of the rms vision-carrier level, the signal-to-noise ratio, the crossmodulation, the intermodulation products and other quantities.

The MSU incorporates a weighting filter in compliance with VDE 0876 which, in conjunction with the antennas referred to above or the Absorbing Clamp MDS-21, enables **radio-interference measurements** according to VDE and CISPR regulations. A scale calibrated in dB(μ V/MHz) with an indicating range of 40 dB is provided on the MSU for interference measurements according to MIL standards.

The selective test equipment can also be used for **radiosurveillance and monitoring**. For long-term recording of frequency band occupancies the Radio Monitoring Recorder ZSG 3 can be connected. The adjustable recording threshold can be superimposed as a level line on the screen display.

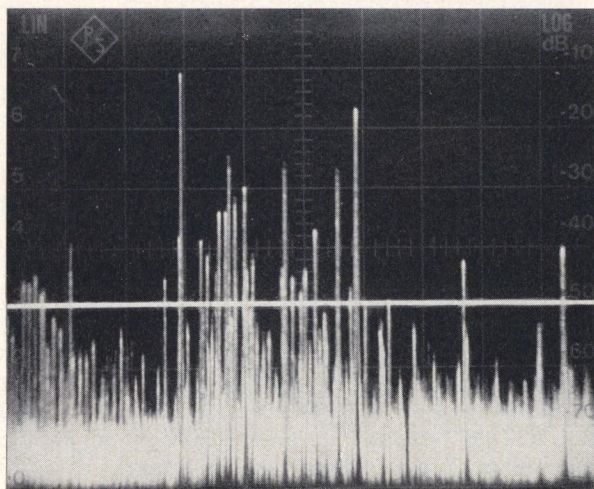


Fig. 4 Expanded-extract display with superimposed receiver-tuning marker and recorder response-level line.

Description

The nucleus of the Selective Test Equipment is the double-conversion superheterodyne receiver **ESU 2** covering the frequency range 25 to 1000 MHz in 9 subranges. Depending on the particular subrange, the 1st IF is either 199.3 MHz or 339.3 MHz. The 2nd IF is 10.7 MHz in all subranges.

The RF signal is passed via a level switch in the form of a 10 dB/step motorized attenuator which also connects the level- and frequency-calibration signals to the tuner input.

The tuner control circuit directs the RF input signal and the internal or external tuning voltage to the group of **9 varactor-controlled subrange tuners**; it also ensures that the signal of the 1st IF and of the 1st local oscillator are connected to the appropriate

output lines. The tuning voltage may be derived from the manual tuning potentiometer of the ESU 2, from the Frequency Controller (with DFC and external input) or from the Panoramic Adapter (with RF analysis). The voltage of the 1st local oscillator is applied to the calibration generator for producing the calibration voltage, as well as made available to the Frequency Controller EZK for display and control of the reception frequency.

The crystal-controlled **2nd local oscillator** of the ESU 2 converts the signal at either 1st IF to the common 2nd IF of 10.7 MHz.

The 2nd IF signal can be further processed on three different paths:

1. In the **Panoramic Adapter EZP** with spectral display of the RF input signal.

With RF analysis the receiver tuning is swept through one subrange. The EZP filters out the IF signal with bandwidths of 120 kHz or 50 kHz (expanded-extract display). The Selective Test Equipment operates thus as analyzer with tracking preselection.

With IF analysis the EZP has no influence on the receiver tuning. The IF signal from the receiver is analyzed by the EZP with sweep widths of 2 MHz, 200 kHz or 20 kHz and a resolution of 15 kHz, 4.5 kHz or 1.5 kHz. The spectral part within the receiver IF bandwidth is displayed and its modulation content can be monitored.

2. In the **IF wideband amplifier** of the ESU 2 with a bandwidth of about 1 MHz and an adjustable gain (gain control range 70 dB). The amplitude-demodulated signal is direct-coupled to the VIDEO output (0 to 500 kHz) for examination of pulse waveforms, interfering AM signals etc. on an oscilloscope.
3. In the **2nd IF amplifier** of the ESU 2 with the IF filter section (bandwidths of 15, 120 and 300 kHz) and with gain-control and demodulation stages. With the automatic voltage calibration the overall gain of the ESU 2 is adjusted to the nominal value by adjusting the basic IF gain. In addition, the 2nd IF passes through a circuit the gain of which is constant in the linear response mode and controlled when logarithmic indication is selected.

The **CISPR interference weighting** involves an IF bandwidth of 120 kHz and a further conversion to 450 kHz. The detected signal is weighted as specified in CISPR publications 2 and 4 and indicated.

The amplified AF signal is available at an **AF output** for connection of a loudspeaker or headphones. A disconnectible squelch suppresses the AF as soon as the display voltage drops below a threshold adjustable within the total indicating range of the ESU 2. Each of the three individual units has a logic circuit which executes the commands from the front panel or the remote-control sockets and combines them, thus facilitating operation and greatly reducing setting errors.

Specifications

Frequency range	25 to 1000 MHz, nine subranges																				
	<table> <tr> <th>subrange</th><th>1st intermediate frequency</th></tr> <tr> <td>24 to 42 MHz</td><td>199.3 MHz</td></tr> <tr> <td>40 to 70 MHz</td><td>199.3 MHz</td></tr> <tr> <td>67 to 110 MHz</td><td>339.3 MHz</td></tr> <tr> <td>100 to 175 MHz</td><td>339.3 MHz</td></tr> <tr> <td>170 to 270 MHz</td><td>339.3 MHz</td></tr> <tr> <td>265 to 420 MHz</td><td>199.3 MHz</td></tr> <tr> <td>410 to 605 MHz</td><td>339.3 MHz</td></tr> <tr> <td>595 to 805 MHz</td><td>339.3 MHz</td></tr> <tr> <td>800 to 1005 MHz</td><td>339.3 MHz</td></tr> </table>	subrange	1st intermediate frequency	24 to 42 MHz	199.3 MHz	40 to 70 MHz	199.3 MHz	67 to 110 MHz	339.3 MHz	100 to 175 MHz	339.3 MHz	170 to 270 MHz	339.3 MHz	265 to 420 MHz	199.3 MHz	410 to 605 MHz	339.3 MHz	595 to 805 MHz	339.3 MHz	800 to 1005 MHz	339.3 MHz
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Frequency adjustment	a) continuous range selection using slide switch and coarse/fine drive; drum scale of 2-m total length, resolution about 100 kHz/mm in lowest range, about 1 MHz/mm in uppermost range b) quasi-continuous at three selectable speeds on Frequency Controller with digital readout; 100-Hz increments and resolution c) external in BCD code, setting time 0.5 s (typical) including automatic range selection																				
Frequency indication, digital	digital readout on EZK																				
with manual tuning on ESU 2	6 digits																				
with EZK-controlled tuning	7 digits																				
Resolution	100 Hz in DFC mode ¹⁾ 2)																				
Noise figure																					
up to 400 MHz	8 dB (typical)																				
up to 1000 MHz	10 dB (typical)																				
RF input	type N female connector, adaptable ³⁾																				
Input impedance	50 Ω																				
VSWR																					
for level-switch positions $< +20$ dB	< 2																				
for level-switch positions $\geq +20$ dB	< 1.15																				
Maximum input voltage	$1 V_{rms}$ for switch positions $\leq +10$ dB $3 V_{rms}$ for switch position $+20$ dB $5 V_{rms}$ for switch positions $\geq +30$ dB																				
Suppression of intermodulation distortion (a_{d3}) for a spurious product of 0 dB(μV)	> 70 dB, in level-switch positions ≥ 0 dB																				
Spurious oscillator voltage at RF input with 50- Ω termination	$< 10 \mu V$, $< 1 \mu V$ typ.																				
Image-frequency rejection	> 70 dB																				
IF rejection	> 80 dB																				
2nd intermediate frequency	10.7 MHz																				
6-dB IF bandwidth	15 kHz, 120 kHz, 300 kHz, switch selected																				
3rd intermediate frequency	450 kHz																				
6-dB IF bandwidth	120 kHz																				
	} only for CISPR-weighted } interference measurements																				
Measurement range	-10 to $+120$ dB(μV) for linear average-value mode, switchable in 10-dB steps																				
Measurement error	$\leq \pm 1$ dB for input signals $\geq 1 \mu V$ and linear average-value mode																				
Indicated noise with 15-kHz IF bandwidth and linear average-value mode	≤ -13 dB(μV), -16 dB(μV) typ.																				
Voltage indication	analog																				

¹⁾ DFC = digital frequency control.

²⁾ For details on accuracy and long-term stability see Frequency Controller EZK, Preliminary Information 225 001 (N 6-258).

³⁾ Screw-in adapters are available for easy conversion to other connector standards: ask for data sheet 902 100.

Display ranges	20 dB, linear 60 dB, logarithmic 40 dB, logarithmic (peak-value measurement of wide-band interferences in dB(μ V/MHz) according to MIL at 300 kHz IF bandwidth 7 dB for interference measurements according to CISPR
Display modes	
Average value	linear and logarithmic
Peak value	linear: charging time constant less than shortest IF-filter rise time logarithmic: for pulse-repetition frequencies > 10 Hz hold time: 3 s, discharge time: 5 ms
Weighted	according to VDE 0876 and CISPR publications 2 and 4
Types of demodulation	FM, AM, A1, switch-selected

Outputs

Generator output (tracks receiver frequency)	type N female connector ¹⁾
EMF	86 dB(μ V) ± 0.5 dB, disconnectible, $R_s = 50 \Omega$
IF — 10.7 MHz	EMF 200 mV, female BNC connector
6-dB bandwidth	according to selected IF bandwidth
IF — 450 kHz	EMF 15 mV, at full scale deflection with sinewave signal ($R_s = 50 \Omega$); female BNC connector; only connected during CISPR interference measurements
6-dB bandwidth	120 kHz
AF	JK-34 jack
Output power	variable up to 1.2 W into 8 to 16 Ω ($R_s = 10 \Omega$)
Squelch	disconnectible; threshold variable over full range of meter
VIDEO (0 to 500 kHz)	EMF 2 V, adjustable ($R_s = 75 \Omega$); female BNC connector
Demodulator outputs	2 female BNC connectors
Frequency range	AM 0 to $\frac{B_{IF}}{2}$ Hz
EMF	2 V for 100% AM ($R_s = 75 \Omega$)
	FM 0 to $\frac{B_{IF}}{2}$ Hz max. ± 1 V for ± 125 -kHz frequency deviation ($R_s = 75 \Omega$)
Recording outputs	2 female BNC connectors
X (frequency) axis	0 to 10 V in each subrange ($R_s = 10 \text{ k}\Omega$)
Y (signal-level) axis	0 to 5 V proportional to meter reading ($R_s = 10 \text{ k}\Omega$)
Digital output	frequency readout on EZK; 50-way female connector (7 digits, BCD code parallel, TTL)
Remote-control inputs and outputs	Amphenol connector, order no. 018.5904.00
ESU 2	two 50-way connectors with inputs and outputs
EZP	50-way connector with inputs and outputs
EZK	two 50-way connectors control input and data output

Panoramic display on EZP

Subrange display ²⁾ (RF analysis)	
Sweep width	1 receiver subrange and/or selectable section thereof
Resolution	120 kHz or 50 kHz (expanded-extract display)
Sweep time	40 ms to 50 s (recording)
IF display (IF analysis)	
Sweep width	20 kHz, 200 kHz, 2 MHz
Resolution	1.5 kHz, 4.5 kHz, 15 kHz
Sweep time	40 ms to 50 s (recording) ³⁾
Level display (switch-selected)	> 70 dB log. or 20 dB lin.
Dynamic range free from interferences	≥ 70 dB

¹⁾ Screw-in adapters are available for easy conversion to other connector standards: ask for data sheet 902 100.

²⁾ In the case of subrange display the AF amplifier is cut off and the frequency to which the receiver is tuned shown as a marker on the screen. Start and stop of the expanded-extract display are indicated by two additional markers. Simultaneous display of subrange and expanded extract is possible.

³⁾ Minimum sweep time is ensured automatically, sweep range and resolution being freely selectable.

Screen size	10 cm × 8 cm (internal graticule 10 dB/cm, calibrated)
Screen type	long-persistence screen P2 with internal graticule

General data

Nominal temperature range	0 to +40 °C
Operating temperature range	0 to +40 °C
Storage temperature range	−25 to +70 °C
AC supply	115/125/220/235 V $^{+10}_{-15}$ %, 47 to 420 Hz (150 VA)
Overall dimensions (W×H×D)	520 mm × 400 mm × 535 mm (cabinet)
Weight	60 kg

Order designation	► VHF-UHF Selective Equipment MSU 253.2016.55
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Accessories supplied

3 power cables	025.2365.00	} Accessories supplied with EZP, ESU 2, EZK
2 connecting cables	251.9494.00	
Battery cable for ESU 2	252.0084.00	
Manual		

Recommended extras

Radio Monitoring Recorder ZSG 3	242.6015.92
Connecting cable (EZP-ZSG 3)	251.9488.00
XY Recorder ZSK 2	247.4010.04
Headphones (with plug PL 55)	110.2959.00
RF Clamp-on Current Probe ESU-Z (25 to 300 MHz)	100.1137.02
RF cable for connection of RF Current Probe	204.1090.02
Absorbing Clamp MDS-21	194.0100.50
BNC-female to N-male adapters (for RF Current Probe and MDS-21)	118.2812.00
Antennas for field-strength measurements see Preliminary Information HFU 2, 253 001	
Recorder Adapter ESU 2-Z1	290.6011.92
Code Converter PCW	244.8015.92
Card Reader PCL	248.6017.02

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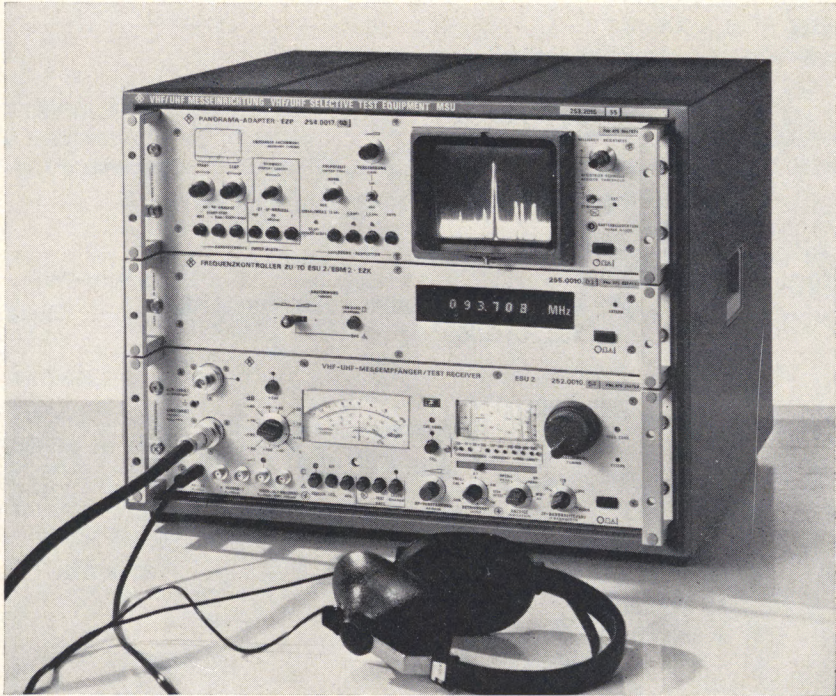


Fig. 5
MSU with headphones
(for radiomonitoring etc.).

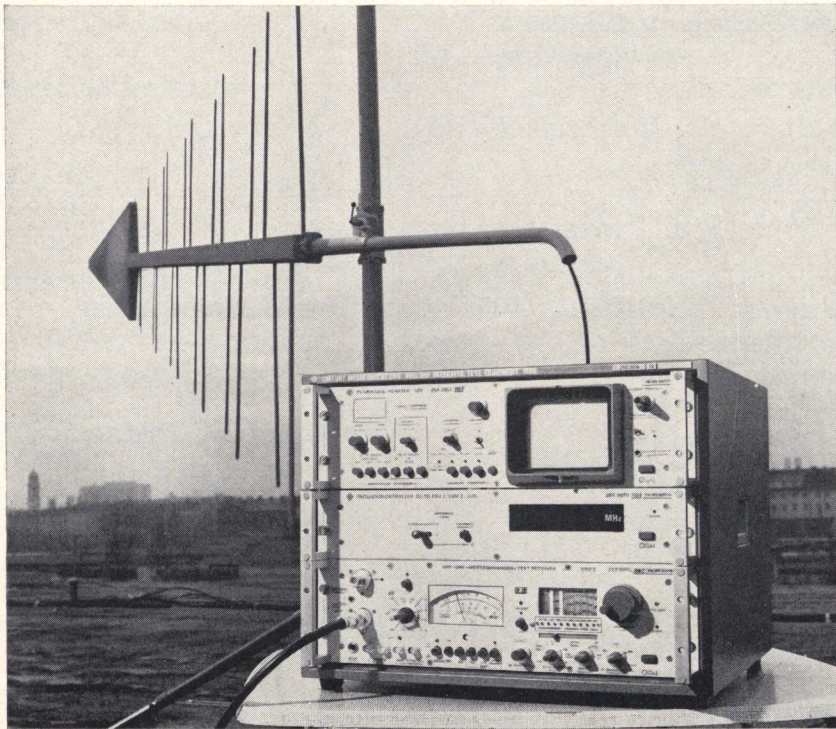


Fig. 6
MSU and HL 023 Antenna.